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Additions to the diversity of lichens and lichenicolous fungi living on decaying wood in Finland

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Crustose lichens and lichenicolous fungi growing on decaying wood were examined from 13 study areas in Finland. *Epigloea urosperma* is reported as new to Finland and *Lecania furfuracea* as new to Fennoscandia. In addition, the taxonomy and habitat requirements of six *Micarea* species are discussed. The species were recently added to the checklist of Finnish lichens based on collections included in this work.

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Introduction

In their comprehensive review based on herbarium material, Spribille et al. (2008) found that 550 lichen species occupy dead wood in Fennoscandia and Pacific Northwest of North America. Of these, 132 species are obligate lignicoles not known from other substrates and 418 are regarded as facultative lignicoles, i. e. as species that occupy dead wood but are found also from other substrates such as bark of living trees or rock and soil. Most of the obligate lichen species are poorly known microlichens. *Micarea* Fr. is one of the largest genera of obligate lignicoles and, in addition, many *Micarea* species are regarded as facultative lignicoles (Coppins 1983, Czarnota 2007, Spribille et al. 2008).

We collected crustose lichens and lichenicolous fungi from dead wood during the "Research programme of deficiently known and threatened forest species" in 2009-2016 in Finland. Here we provide additional locality data and discuss the taxonomy and habitat requirements of six lignicolous *Micarea* species, which we recently added to the checklist of Finnish lichens (see Jääskeläinen et al. 2015). We also report *Lecania furfuracea* as new to Fennoscandia and the lichenicolous *Epigloea urosperma* as new to Finland. Most of the reported species are probably overlooked owing to their small size and inconspicuous thalli. However, some of the species, such as *Micarea tomentosa,* are likely to be rare and confined to old-growth forests.

Material and Methods

Lichens and lichenicolous fungi were examined from 13 study areas. Eight of the forest stands were located in southern boreal zone (see Ahti et al. 1968), three in the transition zone between southern and middle boreal zones in the biogeographical province of Pohjois-Karjala and two in the middle boreal zone in Kainuu province. We selected both managed forests (six stands) and old-growth forests (seven stands) in our study. Managed and old-growth forests were defined on the

basis of their forest history. The managed stands were subjected to forestry during the late 20th century, whereas the old-growth stands had little signs of recent human influence such as cut stumps. Stand age usually varied between 50 and 85 years in the managed stands. The forest stands were dominated by *Picea abies* with mixed *Pinus sylvestris* and *Betula* spp. Specimens were sampled from one rectangular plot of 20 m × 50 m in each study area. Decay stage of dead trees was estimated using a five-class decay scale, where decay class 1 refers to recently dead tree, 2 to early stage, 3 to mid stage, 4 to late stage and 5 to almost decomposed tree (Renvall 1995). We focused mainly on fallen decaying *Picea abies* trees and examined lichen flora from three trees in decay stages 2, 3, 4, and 5; which makes altogether 12 trees from each study plot. For comparison, we collected lichens from some stumps and dead standing trees.

Altogether ca. 4000 lichen specimens were collected. Most samples were identified in the laboratory using morphological, anatomical, chemical and molecular characters. All the specimens are deposited in H. Sample plots are referred to by their numbers according to the list below.

List of sample plots

1. *Kainuu (Kn):* Sotkamo, Rommakkovaara, *Picea abies* dominated old-growth forest, 63.8901°N, 28.4859°E.
2. *Kainuu (Kn):* Sotkamo, Vuokatti hill, *Picea abies* dominated old-growth forest, 64.1235°N, 28.2791°E.
3. *Pohjois-Karjala (PK):* Lieksa, Koli National Park, *Picea abies* dominated old-growth forest, on E-slope of the hill, 63.1033°N, 29.8140°E.
4. *Pohjois-Karjala (PK):* Lieksa, Koli National Park, *Picea abies* dominated old-growth forest, on E-slope of the hill, 63.1028°N, 29.8149°E.
5. *Pohjois-Karjala (PK):* Lieksa, Koli, *Picea abies* dominated managed forest, 63.0798°N, 29.6191°E.
6. *Etelä-Häme (EH):* Hämeenlinna, Valkea-Kotinen, *Picea abies* dominated old-growth forest, 61.2417°N, 25.0613°E.
7. *Etelä-Häme (EH):* Hämeenlinna, Evo, protected *Picea abies* dominated managed forest, 61.2088°N, 25.1363°E.
8. *Etelä-Häme (EH):* Iitti, Vuolenkoski, near road Pikitie, *Picea abies* dominated managed forest, 61.0810°M, 26.2187°E.
9. *Etelä-Häme (EH):* Iitti, Vuolenkoski, Taipale, *Picea abies* dominated managed forest, 61.0908°N, 26.2384°E.
10. *Uusimaa (U):* Vantaa, Vestra, Herukkapuro nature reserve, by the river Herukkapuro, *Picea abies* dominated old-growth forest, humid mixed grove, 60.3215°N, 24.7658°E.
11. *Uusimaa (U):* Tuusula, west of Korso, shaded and dense *Picea abies* dominated managed forest, 60.3544°N 25.0322°E.
12. *Uusimaa (U):* Sipoo, Rörstrand, *Picea abies* dominated old-growth forest, 60.4639°N, 25.1918°E.
13. *Varsinais-Suomi (V):* Vihti, Nuuksio, recently protected *Picea abies* dominated managed forest, 60.2973°N, 24.4611°E.

Results

Epigloea urosperma Döbbeler

Epigloea urosperma (Fig. 1) is a lichenicolous fungus best recognized by its 32 spored asci and 1-septate ellipsoid ascospores, which have two filamentous appendages at both ends (Döbbeler 1994). According to Czarnota & Hernik (2013) it grows exclusively on *Placynthiella dasaea* (Stirt.) Tønsberg but in our study it was found also on *P. icmalea* (Ach.) Coppins & P. James. The two host species were collected from bark or lignum of several fallen *Picea abies* trees (the decay stage ranging from early stage to almost decomposed) both in managed and old-growth stands. Neither of the species, however, are obligate lignicoles but grow also on bark of living trees and/or on plant debris (Printzen et al. 2002, Hauck et al. 2013, Gasparyan & Sipman 2016).

Epigloea urosperma was found from eight out of the 13 examined study plots in southern and middle boreal zones. The frequent occurrence suggests that the species is not rare but more likely overlooked and under-collected because of its inconspicuous and lichenicolous habit. *E. urosperma* was previously known from Austria, Germany, Great Britain, Poland, Sweden and Switzerland in Europe (Döbbeler 1994, Santesson et al. 2004, Pérez-Ortega & Barreno 2006, Kukwa & Flakus 2009, Czarnota & Henrik 2013) and from Bolivia in South America (Flakus & Kukwa 2012).

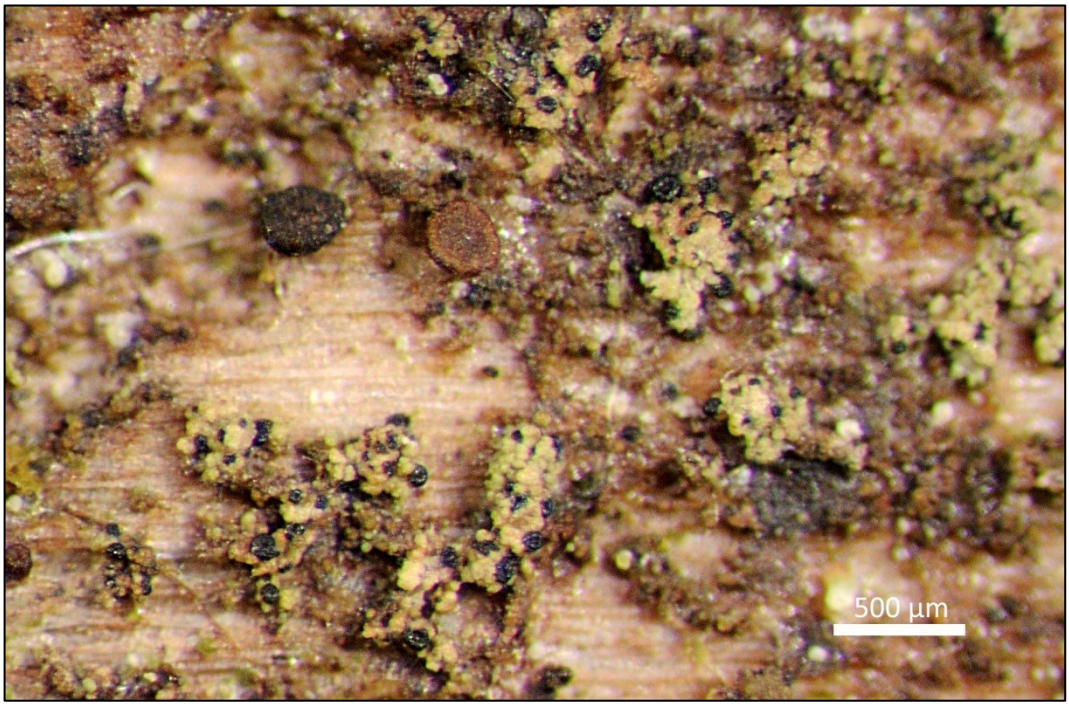

Figure 1. *Epigloea urosperma.* Launis 1884 (H). Photo A. Launis.

Specimens examined: Sample plot 11: on *Placynthiella dasaea*, Launis 2622, 2605, 2707; ibid, on *Placynthiella* sp., Launis 2671; ibid, on *Placynthiella icmalea*, Launis 2688, 2676. Sample plot 10: on *Placynthiella icmalea*, Launis 2361. Sample plot 13: on *Placynthiella dasaea*, Launis 3033, 3134, 3149, 3182; ibid, on *Placynthiella icmalea,* Launis 3095, 3159, 3173. Sample plot 6: on *Placynthiella dasaea*, Launis 571, 607; ibid, on *Placynthiella* sp. Launis 598, 656, 667. Sample plot 8: on *Placynthiella icmalea*, Launis 692. Sample plot 9: on *Placynthiella dasaea,* Launis 1041. Sample plot 3: on *Placynthiella dasaea*, Launis 1873, 1884; ibid, on *Placynthiella icmalea,* Launis 1897. Sample plot 2: on *Placynthiella dasaea*, Launis 421.

Lecania furfuracea Vězda

The Finnish specimen of *Lecania furfuracea* was identified based on its finely sorediate green thallus, pale brown apothecia with vanishing margin and mostly simple spores (Vězda 1999). Our specimen also closely matches the isotype deposited in H (Vězda, 30 May 1989, *Lichenes Rariores Exsiccati* no. 386). It also has a similar ITS profile to the *L. furfuracea* specimen deposited in Genbank (accession number AM292683). According to Reese Næsborg et al. (2007) the species falls outside of *Lecania* s. str. and is closely related to *L. naegelii* (Hepp) Diederich & van den Boom and *Cliostomum tenerum* (Nyl.) Coppins & S. Ekman. To our knowledge it has been recorded so far only from the Czech Republic (Vězda 1999, Halda 2006), where it was listed in the threat category DD (data deficient) (Liška et al. 2008). It is here reported as new to Fennoscandia known only from a single locality in eastern Finland in Koli National Park.

Specimen examined: Sample plot 4: on standing decaying (early stage) *Picea abies*, Launis 2104.

Micarea contexta Hedl.

Micarea contexta is an endoxylic species characterized by small and black ascomata, 1-septate ascospores with upper cell characteristically broader than the lower, and sessile pycnidia (Figs 2–3). It can be confused with several other species with inconspicuous thallus and similar ecological preferences such as *M. deminuta* Coppins, which, however, has simple spores and *M. nigella* Coppins, which has stalked pycnidia (Czarnota 2011). Poorly developed specimens of *M. melaena* (Nyl.) Hedl., may resemble *M. contexta* but the former species has superficial, granular thallus, larger ascomata, 3-septate spores, more numerous paraphyses and longer microconidia (Coppins 1983). Some of the Finnish specimens lacked ascomata but were identified as *M. contexta* based on sessile and K– or green intensifying pycnidia. The species was originally recorded from central Sweden (Coppins 1983) and is also known from the British Isles (Coppins 2009), the Czech Republic (Palice 1999), Switzerland (Gronen 2006), Norway (Holien et al. 2015) and Poland and Russia (Czarnota 2011). It is probably an overlooked species in Finland, as it was found from several localities (from eight of the 13 study areas) both in managed and old-growth stands. In addition to our own specimens, two collections deposited in H were identified or confirmed as *M. contexta*.

Specimens examined: Sample plot 10: on lignum of fallen decaying (early stage, mid stage, late stage) *Picea abies*, Launis 2347, 2535, 2586, 2410, 2350; ibid, on bark of standing decaying (mid stage) *Picea abies*, Launis 2578. Sample plot 11: on bark of standing decaying *Picea abies* (early stage, late stage), Launis 2911, 2748, 2844. Sample plot 13: on lignum of fallen decaying (early stage, mid stage, late stage) *Picea abies*, Launis 2956, 2986, 3020, 3042, 3204, 3205, 3209, 3216, 2996, 3105, 3125. Sample plot 7: on lignum of fallen decaying (early stage) *Picea abies*, Launis 2782. Sample plot 6: on lignum of fallen decaying (early stage) *Picea abies*, Launis 569, 584. Sample plot 3: on lignum of fallen decaying (early stage, mid stage, late stage) *Picea abies*, Launis 1946, 1965, 1803, 1808, 1914, 1822, 1826. Sample plot 4: on lignum of fallen decaying (late stage) *Picea abies*, Launis 2054, 2060; ibid, on lignum of standing decaying (late stage) *Picea*

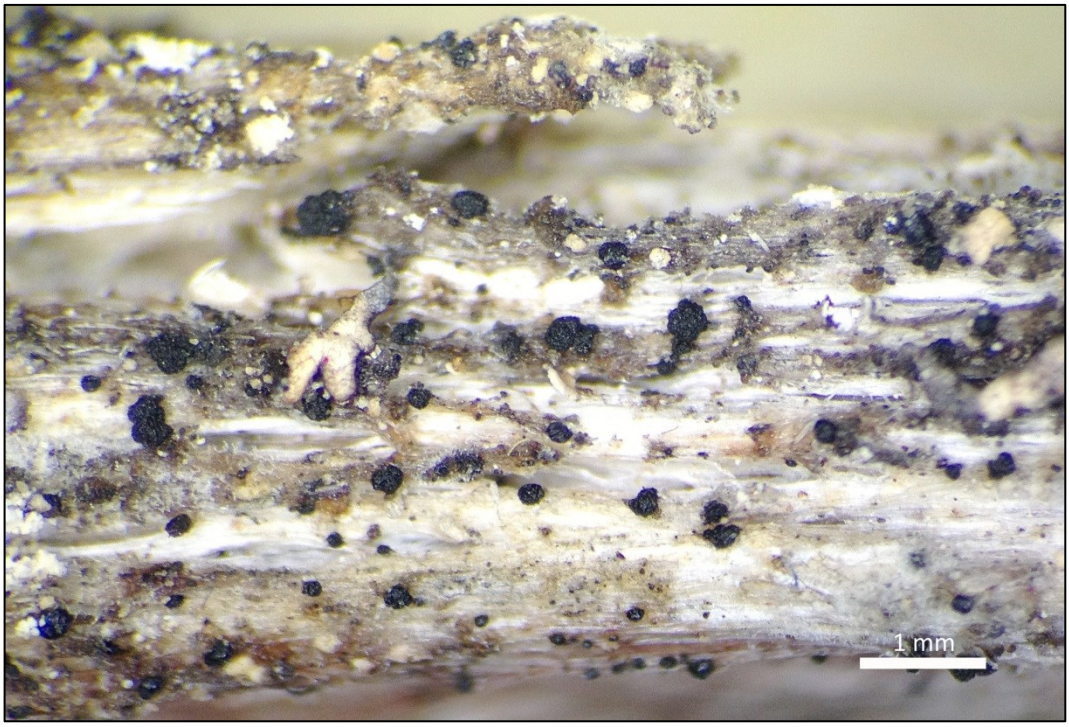

Figure 2. *Micarea contexta*. Launis 3105 (H). Photo A. Launis.

abies, Launis 2129. Sample plot 5: on lignum of fallen decaying (early stage) *Picea abies*, Launis 2225. Sample plot 1: on lignum of decaying standing (early stage) *Picea abies*, Launis 251. Sample plot 2: on lignum of fallen decaying (early stage, mid stage) *Picea abies*, Launis 311, 365, 396, 457, 345, 351, 419, 452; ibid, on bark of fallen decaying (early stage) *Picea abies*, Launis 545. *Kainuu (Kn)*: Kuhmo, Honkavaara, N part; old virgin, paludified *Picea*-dominated forest on N-slope, on basal trunk of old *Salix caprea* at mire margin; on lignum in bark crevice, N6 (tree 18), 1992-05-29, 63.896737°N, 29.709256°E, Mikko Kuusinen 3200, conf. A. Launis. *Kittilän Lappi (KiL):* Kittilä, Ruoppaköngäs, 67,907° 24,399° on lignum of fallen decaying *Picea abies*, 2015-08-14, Veli Haikonen 30292, det. A. Launis.

Micarea melaeniza Hedl.

Micarea melaeniza is a lignicolous species, which forms inconspicuous or endoxylic thallus with small, black apothecia and is in this respect similar to for example *M. contexta* and *M. nigella*. *Micarea melaeniza*, however, has stalked pycnidia and simple spores, whereas *M. contexta* is characterized by sessile pycnidia and 1-septate spores. *Micarea melaeniza* and *M. nigella* are closely related (Czarnota 2007) and differ mainly in their hypothecial and pycnidial pigmentation (bright green hymenium, red-brown hypothecium that does not turn green in K in *M. melaeniza* vs. purple-brown, K+ green pigment in the ascomata and pycnidia in *M. nigella*) and in size of mesoconidia (shorter in *M. melaeniza*) (Coppins 1983). According to Czarnota (2007), however, the differences are not always clear and the two taxa might even be conspecific.

Micarea melaeniza was found only from one study area in southern Finland, growing on almost decomposed standing *Picea abies*. Reports from other countries are also scattered: to our knowledge it is known only from Sweden from three collections (Coppins 1983), Austria (Berger

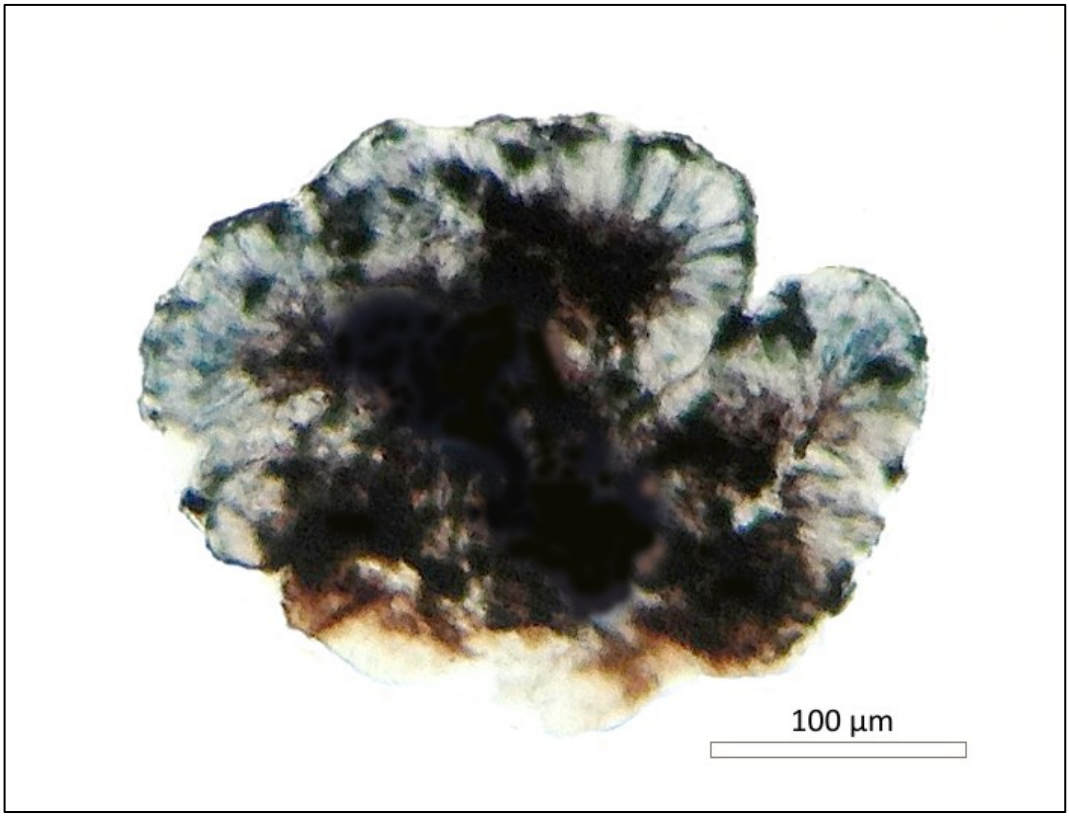

Figure 3. *Micarea contexta*, cross section of an apothecium. Launis 3105 (H). Photo A. Launis.

& Türk 1991) and Mongolia (Palka & Śliwa 2006). It may be a rare species, as Coppins (1983) suggested, and restricted to localities with large amounts of dead wood. However, it is most certainly also an overlooked species owing to its small size and difficulties in identification.

Specimens examined: Sample plot 10: on standing decaying (almost decomposed) *Picea abies*, Launis 2430, 2438.

Micarea nigella Coppins

The Finnish specimens were identified as *Micarea nigella* based on their pycnidial and/or ascomatal characters, i.e. stalked and black pycnidia, simple spores and purple-brown pigment (K+ green) in the ascomata and pycnidia (see Coppins 1983). The species has earlier been recorded from Denmark and the British Isles (Coppins 1983), Belgium and France (Sérusiaux et al. 1999), the Czech Republic (Palice 1999), Poland (Czarnota & Coppins 2000), Norway (Holien 2001) and Sweden (Andersson 1992). In Finland it was found only in three study areas; two located in southern Finland and in eastern Finland in Koli National Park. We are currently examining the phylogeny of the species using molecular characters and our preliminary results suggest that *M. nigella* is genetically variable and may in fact constitute of several species. Therefore, the

frequency or the threat status of *M. nigella* cannot be assessed before the taxonomy of the species is examined more in detail.

Specimens examined: Sample plot 12: on lignum of fallen decaying (early stage) *Picea abies*, Launis 1711. Sample plot 7: on lignum of standing deacying (almost decomposed) *Picea abies*, Launis 2851. Sample plot 3: on lignum of fallen decaying (early stage, mid stage) *Picea abies*, Launis 1971, 1974, 1921; ibid, on bark of fallen decaying (mid stage, late stage) *Picea abies*, Launis 1865, 1870, 1923, 1909.

Micarea nowakii Czarnota & Coppins

Micarea nowakii can be distinguished from morphologically similar *M. denigrata* (Fr.) Hedl. and *M. misella* (Nyl.) Hedl. by its production of micareic acid. It differs anatomically from *M. denigrata* by its clearly visible olive-black epithecium and from *M. misella* by its mainly 1-celled ascospores (Czarnota 2007). The species belongs to the *Micarea prasina* group and is closely related to the recently described *M. herbarum* M. Brand, Coppins, Sérus. & van den Boom (van den Boom et al. 2017, Launis et al., unpubl.) from which it is distinguished by its smaller ascospores and wider mesoconidia (van den Boom et al. 2017). The species was previously known from the Czech Republic (Malíček et al. 2014), Germany (Czarnota et al. 2014), Poland, (Czarnota 2007, Kukwa et al. 2008), Romania (van den Boom et al. 2017) and Sweden (Svensson & Westberg 2010). Czarnota (2007) considered the species as an early colonizer that prefers exposed and well-lit localities. In Finland, *M. nowakii* was collected only from one locality in southern Finland on a log of *Picea abies* at well-lit edge of a managed forest. The ecological preferences of *M. nowakii* suggest that it may be rather common in Finland but overlooked owing to its small size and inconspicuous thallus. Furthermore, thorough examination of herbarium material of morphologically similar species (*M. denigrata* and *M. misella*) are needed to fully understand the distribution of *M. nowakii* in Finland.

Specimen examined: Sample plot 8: on bark of fallen decaying (early stage) *Picea abies*, Launis 684.

Micarea soralifera Guzow-Krzemińska, Czarnota, Łubek & Kukwa

Micarea soralifera is best recognized by its green and well-limited, K+ violet and C+ violet (sedifolia grey pigment) soralia (Guzow-Krzemińska et al. 2016). It is closely related to *M. prasina* Fr. (Guzow-Krzemińska et al. 2016, Launis et al., unpubl.) and differs from that species by forming a bluish grey green thallus and producing soralia. The species was first reported from Poland and the Czech Republic (Guzow-Krzemińska et al. 2016), and is also known from Sweden in Uppland Province (Svensson et al. 2017). It has been collected mainly from decaying logs in humid and often shaded habitats, corresponding well with the single locality in Finland.

Specimen examined: Sample plot 13: on lignum of fallen decaying (early stage) *Picea abies*, Launis 3075 & Myllys.

Micarea tomentosa Czarnota & Coppins

Micarea tomentosa belongs to the *M. prasina* group (Czarnota & Guzow-Krzemińska 2010, Launis et al., unpubl.) and is similar to *M. hedlundii* Coppins in having stalked, whitish and tomentose pycnidia (Czarnota 2007). It is distinguished from *M. hedlundii* by its bright green thallus, which is composed of granules larger than the goniocysts of *M. hedlundii* (Fig. 4). Pycnidia are usually shorter and brighter than those of *M. hedlundii*, sometimes barrel-like. In addition, *M. hedlundii* contains dull orange pigment (reacting K+ violet, C+ violet) within the

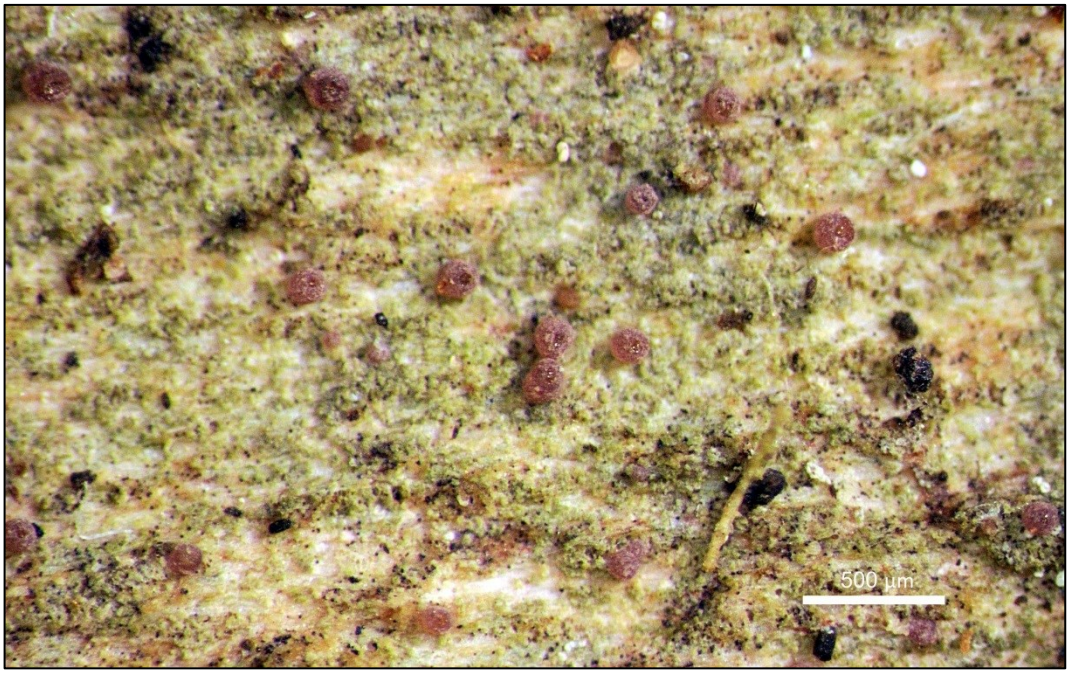

Figure 4. *Micarea tomentosa*. Launis 29151 (H). Photo A. Launis.

goniocysts, while in *M. tomentosa* the pigment is absent. The apothecia of *M. tomentosa* are adnate, pale to slightly brownish (Fig. 4), while the apothecia of *M. hedlundii* are often tuberculate, larger and pinkish brown or brown pigmented (Czarnota 2007).

Micarea tomentosa was found in southern Finland in one of the examined study areas. In addition, the species was later collected from one locality in southern Finland and one in central Finland. The species has earlier been reported from Poland, Slovakia, Estonia, Russia and Sweden mostly growing on decaying stumps and logs in old-growth or natural forests (Czarnota 2007, Suija et al. 2008, Thor & Svensson 2008, Urbanaviche & Urbanavichus 2017). Due to its special habitat requirements *M. tomentosa* is considered to be a rare species and an indicator of ecological continuity for forest habitats (Urbanaviche & Urbanavichus 2017).

Specimens examined: Sample plot 10: on lignum of standing decaying (late stage) *Picea abies*, Launis 2431, 2435, 2437. *Varsinais-Suomi (V):* Lohja, Talpela, Hirsviita 500 m E-NE, NW-slope, herb-rich heath forest (OMT site type), 60.301977°N, 23.975637°E, on rotten stump of *Picea abies*, scarce, 65 m a.s.l., 2017-06-09, Juha Pykälä 49725, det. Launis 2017. *Pohjois-Häme (PH):* Jyväskylä, Vaarunvuoret, nature reserve, humid mixed grove, 61.925400°N, 25.709651°E, on lignum of dead standing *Betula* sp., 2015, Launis 29151.

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